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Aircraft Fuel Cell Repair Equipment

After Iniative Report
AMB-05-005

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14. ABSTRACT
PROBLEM: Aircraft fuel cell repair time is quite lengthy due to dated troubleshooting tools, sealant cure time and repair validation. PROPOSED SOLUTION: Use helium gas to troubleshoot leaks and validate repairs. Use new technology to remove and cure sealant.

15. SUBJECT TERMS
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Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

1. MISSION STATEMENT.

1.1. Problem/Situation. Aircraft fuel cell repair time is quite lengthy due to dated troubleshooting tools, sealant cure time and repair validation.

1.2. Proposed Solution. Use helium gas to troubleshoot leaks and validate repairs. Use new technology to remove and cure sealant.

1.3. Mission Impact. The system demonstrated has the potential to reduce troubleshooting man hours, repair man hours and sealant cure time. The equipment will potentially reduce non-mission capable time by 75%.

2. COURSE OF ACTION.

2.1. Strategy to Achieve. The concept demonstration occurred on a 305 AMW KC-10A and in the fuel cell repair hangar. Aerowing, Inc. provided the equipment used to troubleshoot and repair the fuel leak. The equipment consisted of the helitester, rapid desealer and rapid curing device. Aero Wing personnel trained two groups of Air Force fuel cell technicians on the equipment. The groups employed the equipment independent of each other. Following each demonstration, the technicians completed surveys.

2.1.1. Details. Aerowing, Inc., 2006 Gladstone Ave., Nashville, TN, provided equipment and personnel via a bailment agreement. The demonstration occurred on aircraft 87-0121. The discrepancy repaired was "Fuel leak at #3 tank outboard fuel dipstick panel, class B."

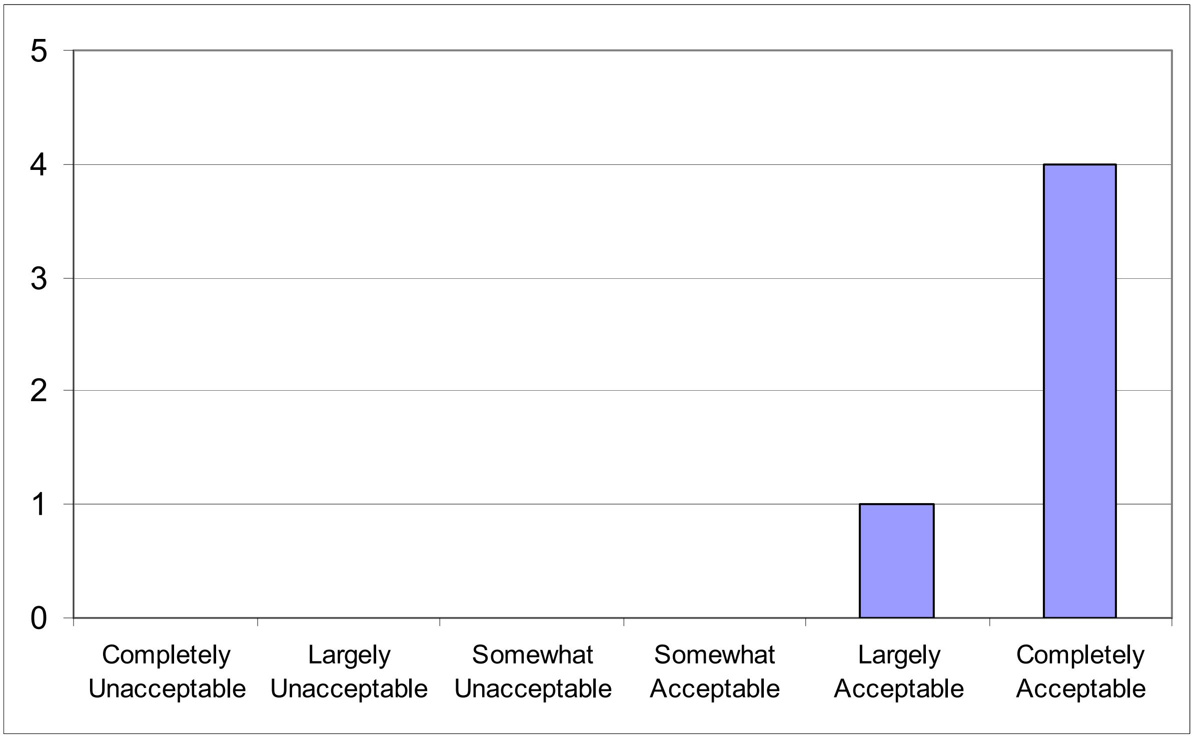
2.2. Objective 1. Determine the helitester's ability to identify a leak path in a timely manner.

2.2.1. Method. Troubleshoot a known leak using current blow-back leak detection methods. Then troubleshoot the same leak using the helitester.

2.2.2. Results. The helitester configured for aviation application was not demonstrated. It failed the start up bit check and would not zero out. A helitester not configured for aviation application did demonstrate the potential for helium to be used as a troubleshooting method. A leak was simulated by passing helium through a fuselage drain hole. Then the helitester was used to identify the source of helium. Based on the technicians feedback, it is evident a better method for troubleshooting than currently used should be explored. The current method of using forced air and soapy water can be very time consuming and laborious.

The technician's feedback on a helium troubleshooting tool was positive. Some comments were, "with this item it cuts down time and could eliminate negative pressure test"; "will save hours of blow back procedures"; and "would save countless hours by eliminating the time it takes to cap off vent systems and open additional fuel tanks to perform positive and negative pressure checks." Survey results are shown in table 2.1.

Table 2.1 Helitester feedback survey results



2.3. Objective 2. Determine the rapid desealer's (RDS) ability to effectively remove sealant.

2.3.1. Method. Use the desealer tool to remove sealant from joints and fastener caps.

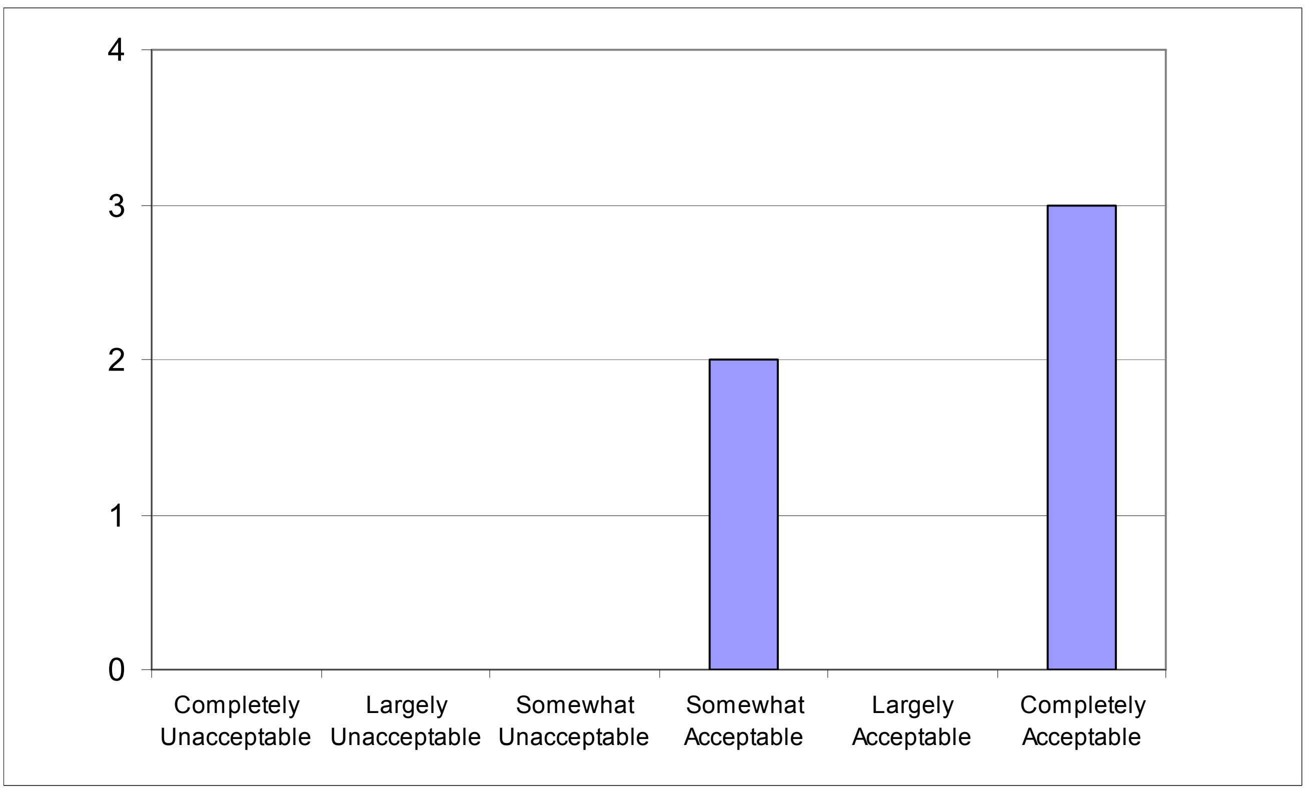
2.3.2. Results. The RDS was very efficient. Sealant was removed from a seam in 30 seconds. Normally it would have taken an hour using current methods to remove this sealant. The RDS is a pneumatic, reciprocating hand tool approximately 16 inches in length. A replaceable plastic tip threads onto the arm. This tip has a point with two different angles. These can be sharpened for reuse, until worn past a certain threshold.

The access panel for the wing tip tank was removed from the aircraft and desealed on the workbench. A training board was also used. Sealant was removed from a .25 inch wide horizontal seam, a corner with rivets, a vertical seam on a horizontal joint and a 6 inch test strip. After all areas were desealed, only minor areas around fastners and corners required conventional cleanup.

The technicians' feedback was positive. Some comments were, "desealer is large and access in areas could be difficult, for large areas the desealer is an excellent tool"; "this is great for larger tanks like the #2 and #3 mains of the C-17A or the #2 main and upper center wing tanks of the KC-10A, but not the smaller tanks"; and "ETIC's could be cut, price of the bits and durability could be a problem." Survey results are shown in table 2.2.

Rapid Desealer on work bench

Table 2.2 RDS acceptability to remove sealant



2.4. Objective 3. Determine the rapid curing device's (RCD) ability to cure sealant at faster rate than stagnant conditions.

2.4.1. Method. Apply sealant to a mock-structure and use the rapid curing device to speed sealant cure time.

2.4.2. Results. PR1422B2NA, a B 1/2 sealant, was used for this demonstration. This sealant was cured in 30 minutes. Under normal conditions, the sealant requires 8 hours. Additionally, the sealant was tack free in 20 minutes; much faster than the normal 6 hours. With set-up and start-up time included, the sealant was cured within one hour.

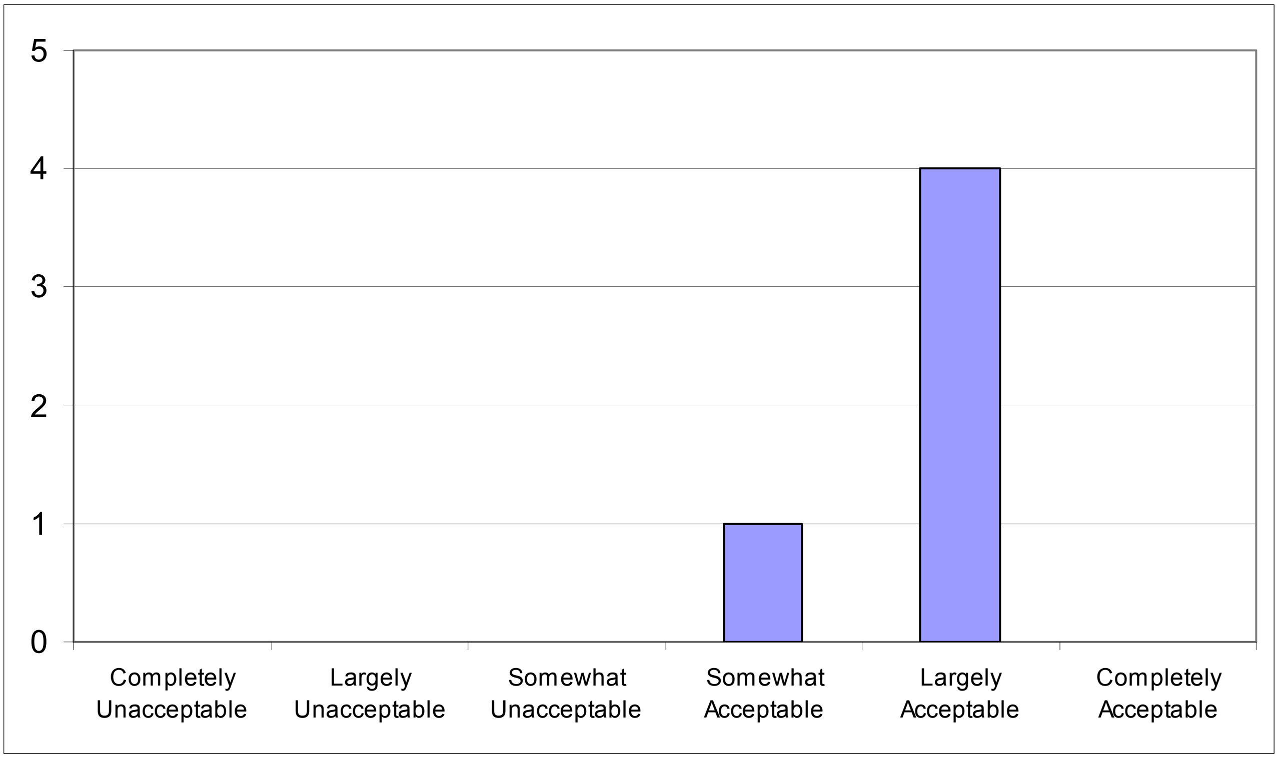
The RCD required approximately 15 minutes set-up time. This time was used to connect 3 inputs, 2 outputs, and 2 probes. Inputs are 110 volt power, air (50 cfps) and propane. Outputs are 28vDC and an air/propane mixture. The 2 probe leads provide temperature input from the sealant and the structure. Once equipment was in position a 10 minute start-up cycle initiated.

The RCD was demonstrated on the training board because the control box is not intrinsically safe and not rated to be within 50 feet of the aircraft. Additionally, the hoses connecting the control box to the emitter heads are not long enough to keep the box outside the safe area. The emitter head/thermoreactor is intrinsically safe and certified for fuel cell environments.

The technician's feedback was positive. Some comments were "at that rate of cure time B2 sealant can be used which would give you a better repair"; "curing of the sealant was rapid and the down time of an aircraft could be decreased"; and "curing time is great" "preps didn't take long." Survey results are shown in table 2.3.

RCD control box with propane, power, and air inputs

Table 2.3 RCD acceptability of time to cure sealant



2.5. Objective 4. Determine the rapid curing device's ability to cure sealant consistently through the sealant's mass.

2.5.1. Method. Examine sealant cured using the rapid curing device and evaluate for consistency of skin formation or air bubble formation.

2.5.2. Results. There was no skin formation or trapped air bubbles. The sealant was cured throughout the entire body. The temperature applied to the sealant ranged from 120° to 130° Fahrenheit. The RCD thermoreactor emission spectrum is nearly identical to the absorption spectrum of paints and sealants. It is this frequency concentration, not the heat, that accelerates the sealant curing.

Sealant being evaluated after curing

2.6. Objective 5. Determine the rapid curing device's functionality within the fuel tanks.

2.6.1. Method. Measure the distance from the rapid curing device to the sealant for distance and angle.

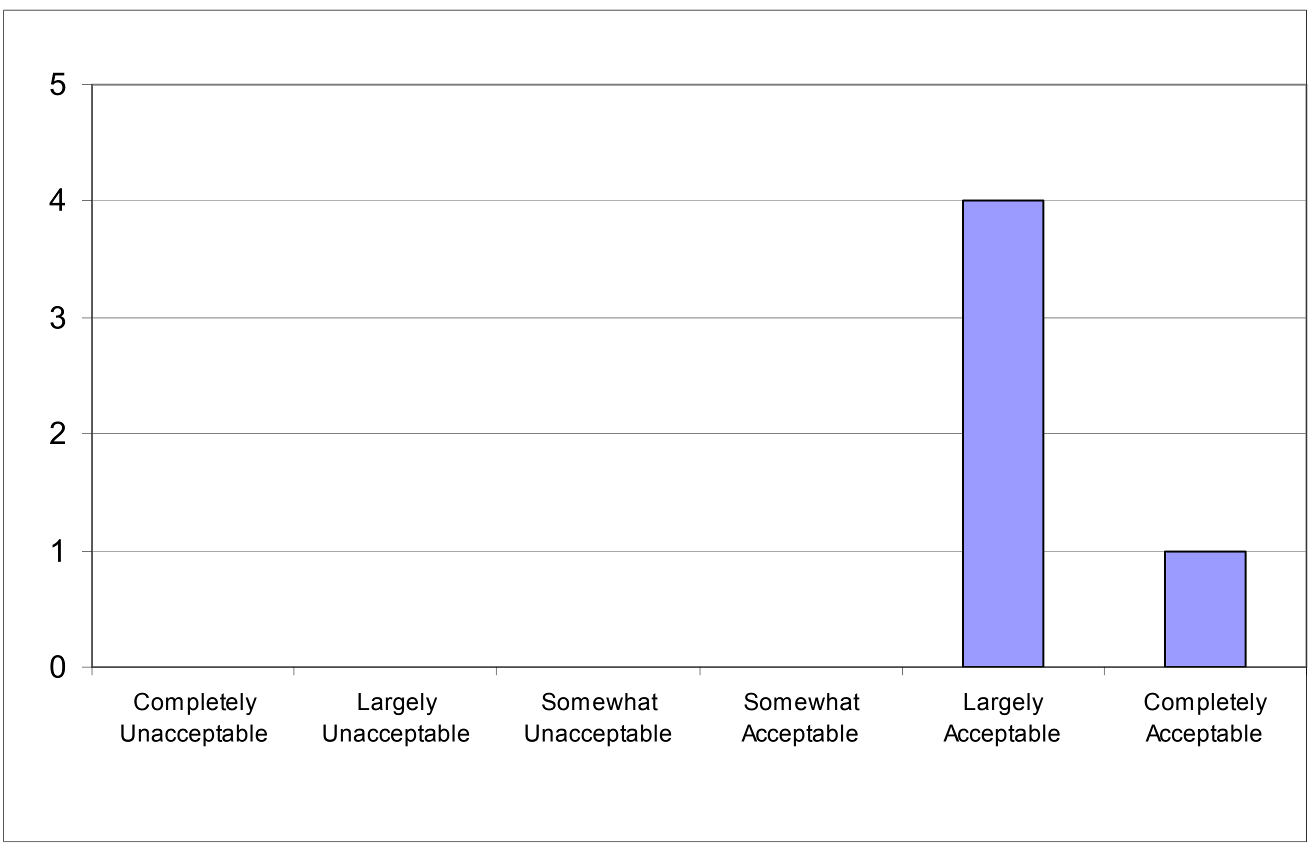
2.6.2. Results. Positioning the emitter head within most heavy aircraft will be possible. The emitter head was positioned with zero angle of deflection and ten inches from the sealant. The emitter head was suspended from a structure above the training board. The manufacturer procedures require line of sight and 8 to 12 inches for maximum effectiveness. Maximum distance recommended is 36 inches.

The tip tank repair demonstration showed limited application for the RCD. The small internal dimensions and multiple piping in the tank offered few potential uses. However, the technicians unanimously agreed the RCD would be functional for the majority of heavy aircraft integral tank repairs. Aerowing provides multiple brackets designed for positioning.

The technicians' feedback was positive. Some comments were "device is user friendly, easy to start and function, could be somewhat bulky and could be a problem depending on access to an area"; "the hoses are my only concern"; and "overall this is a great device and could be a great asset." Survey results are shown in table 2.4.

RCD positioning over training board

Table 2.4 RCD acceptability of functionality within the fuel tanks



2.7. Objective 6. Determine the mapping kit's ability to pressurize the fuel system.

2.7.1. Method. Compare the pressure in the system to the mapping kit's instrumentation and the connections for leaking.

2.7.2. Results. The equipment was not demonstrated. The 327 CLSG did not approve its use and did not deem it applicable to the KC-10.

2.8. Objective 7. Determine the mapping kits ability to assist in troubleshooting.

2.8.1. Method. Verify helium moving through the leak path with the helitester.

2.8.2. Results. The equipment was not demonstrated. The 327 CLSG did not approve its use and did not deem it applicable to the KC-10..

3. RESOURCES.

3.1. Schedule.

Table 3.1. Initiative Schedule

EVENT	START	FINISH
Planning	Jul 05	Dec 05
Demonstration	Jan 06	Jan 06
After Initiative Report	Jan 06	Mar 06
MAFROCC Coordination	Feb 06	Mar 06
AMC/CV Transition Brief	Mar 06	Mar 06

3.2. Funding.

Table 3.2. Resources

RESOURCE	QUANTITY	SOURCE	TIMEFRAME	EST COST
Helitester	1	Aero Wing	Jan 06	$0
Rapid Desealer	1	Aero Wing	Jan 06	$0
Rapid Curing Device	1	Aero Wing	Jan 06	$0
Travel	2	AMB	Aug 05 – Mar 06	$385.75
Total				**$385.75**

3.3. Organizational Support. The AMC fuel cell functional manager provided subject matter expertise. The fuel cell lead engineer, 327 CLSG/GFLT, provided approval for using equipment not listed in technical orders. The 305 MXS provided aircraft and personnel to participate in the demonstration.

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Table 3.3. Required Organizational Support

NAME	AGENCY	PHONE	EMAIL
MSgt James Campbell	AMC/A44J	779-2626	james.campbell@scott.af.mil
MSgt Rory Jackson	305 MXS/MXMCF	650-2062	rory.jackson2@mcguire.af.mil
Mr. Joe Scheirman	327 CLSG/GFLT	336-7889	joseph.scheirman@tinker.af.mil

4. CONCLUSION. The concept of using helium to troubleshoot is valid. However, the helitester wasn't demonstrated due to equipment failure. The non-aviation configuration demonstration provided the proof-of-concept needed to recognize helium as a viable troubleshooting tool.

The rapid desealer is an effective tool for removing sealant in most locations. The size of the RDS and the cost of tip replacements are the only negatives. This tool will significantly decrease repair time. It has additional applications to aerodynamic panel sealant and possibly others. The RDS will reduce downtime and increase aircraft availability.

The rapid curing device is an effective tool for curing sealant in most locations. The RCD greatly reduced the wait time before the fuel tank can be closed and pressurized for a leak check. Currently, fuel cell repairs are completed with only a single layer of a B 1/2 sealant. The RCD will allow for the preferred repair, an A coat and a B 2 coat. This method will provide a better repair in less time. Use of the RCD will result in less non-mission capable time and greater aircraft availability.

5. RECOMMENDATION. Continue to research helium as a troubleshooting tool. Add the rapid desealer to the technical orders and Standard Allowances for applicable maintenance organizations and allow units to purchase. The relative low cost, $4,000 plus $1300 for 100 tips, makes this affordable to most units. Modify the rapid curing device to meet Air Force technical order and safety requirements, then perform full test and evaluation on the RCD.

Philip G Bradley

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Commander, Air Mobility Battlelab